

## Energy efficiency in lighting for industrial buildings – a guide for building managers



Energy Efficiency Office  
DEPARTMENT OF THE ENVIRONMENT

*“ Good lighting makes good business sense, and is a positive contribution to safety and productivity ”*



## Good Practice Guide for building owners and managers

- Potential for at least 50% energy/cost savings in many cases, with attractive payback periods
- Comparison with good practice 'targets' shows scope for improvement
- How lighting consumption and costs can be easily calculated and how energy efficiency can be improved

### Purpose of this Guide

Annual electricity costs for industrial lighting installations are typically £4 to £5 or more per m<sup>2</sup> of floor area (1993 prices), but these costs can be at least halved in many cases by energy efficiency measures that offer extremely attractive payback periods.

The purpose of this Guide is to show how checks can be made to determine the scope that may exist for improving the energy efficiency of a lighting system; and to indicate measures that can bring about these improvements. For a brief overview of the possibilities, see box on right entitled 'Scope for improvement'.

The Guide explains that the annual electrical consumption of a lighting installation is found by multiplying the installed load of the system by the number of hours in a year it is used. (The installed load is the total electrical rating, in watts, of all the system components.) Consumption can therefore be cut by reducing the load, and/or by reducing the time that the lamps are lit.

Target range values are given for installed loads for good practice lighting installations in a variety of industrial building situations. This will enable the reader to see if there is scope



**Tea/coffee warehouse:** when a racking system was installed in a warehouse where everything had previously been stacked on the floor, most of the luminaires had to be changed and relocated. *Case Study 157* explains how the cost of doing so was quickly recovered by subsequent savings on electrical and maintenance costs

for a major reduction in the load of a planned or existing lighting installation.

Ideally, the load will be towards or even below the low end of the recommended range, but the load can be adversely affected by circumstances that are beyond the lighting system specifier's control. Allowance should be made for these factors when comparing a system's installed load with the target range values. The Guide offers pointers that will help the reader to do this. It also discusses actions that can be taken to improve efficiency.

### Scope for improvement

Recent developments have led to the introduction of lamps and luminaires (light fittings) that offer dramatic improvements in energy efficiency, so substantial running cost savings can often be achieved simply by replacing components. And since the efficiency of all lamps declines with use, it is generally good practice to replace them at regular intervals, before they fail.

Most modernisation projects will also involve the introduction or replacement of automatic control systems, with light and/or proximity sensors and time switches. These devices reduce energy consumption by limiting usage of lamps to those times when lighting is actually required, and available daylight is insufficient.

If there have been any significant alterations in a building's structure or the way it is used, then a completely new lighting system may be called for.

Whatever the level of work and investment required (from replacing a single luminaire to installing a completely new system), the capital cost is generally recoverable within two to four years by subsequent savings on electricity bills. In addition, a lighting improvement scheme can lead to valuable savings on maintenance costs.

### GLOSSARY

**Luminaire (light fitting):** Apparatus which controls the distribution of light from one or more lamps. Includes all parts necessary for fixing and protecting the lamps and, where necessary, additional circuit components, together with the means for connecting them to the electricity supply. Luminaire has officially superseded the term 'light fitting', which is still used colloquially.

**Ballast (control gear):** Device connected between the supply and one or more discharge lamps to limit the current through the lamp and, either alone or in combination with a starting device, provide the necessary conditions for starting the lamp. It may also include means for correcting the power factor.

**Illuminance:** The amount of visible radiation (luminous flux) incident on a surface of unit area.

**Lux:** Illuminance measured in lumens per square metre.

**Power factor:** In an electric circuit, the power factor is equal to the root mean square power in watts divided by the product of the root mean square values of voltage and current. A low power factor has the undesirable effect of increasing kVA from the power supply and reducing the useful load that can be carried by supply cables and wiring accessories. Electricity companies may therefore impose higher tariffs for installations that have a low power factor.

**Kilovar (kVAR):** a unit of reactive volt-amperes.



### Introduction

Industrial lighting systems offer great potential for energy and cost savings. On average, they account for about 7% of the electricity used in heavy industry, and 15% of that used in light industry, with typical annual energy costs ranging up to £5 or more per m<sup>2</sup> of floor area, depending on building type (see EEO Energy Consumption Guide 18<sup>(1)</sup>).

In many cases the cost is far higher than necessary, and savings of 50% or more can often be achieved with extremely short payback periods.

For the purpose of this Guide, it is convenient to consider industrial buildings in three categories, with the following definitions.

**Low bay (or low ceiling).** Installations where both tubular fluorescent and high pressure discharge lamps may be used, with mounting heights up to 8 m. The spaces illuminated will usually measure less than 50 x 20 m.

**High bay (or high ceiling).** Installations where high pressure discharge lamps are normally used, with mounting heights of 8 m and above. These spaces will usually measure in excess of 50 x 20 m.

**Warehouse.** Lighting requirements depend on building dimensions and method of storage. This can range from floor stacking to full automation, with moveable racking and computer-controlled robot picking.

Lighting may be needed solely for the safety of staff moving in the area or for routine maintenance of equipment; or it may, for example, have to satisfy more demanding requirements, enabling colours to be identified or small print to be read.

### Lighting standards

The Health and Safety Executive publication 'Lighting for work'<sup>(2)</sup> sets out values for the lighting levels that should be adopted as the minimum to safeguard the safety and health of staff.

The publication considers standards for efficiency and productivity, but these factors are dealt with in greater depth in the CIBSE (Chartered Institution of Building Services Engineers) Code for Interior Lighting 1994<sup>(3)</sup> and CIBSE Lighting Guide LG1: The industrial environment<sup>(4)</sup>. These CIBSE documents make recommendations for various tasks, and typical illuminance values given for normal work range between 150 lux and 500 lux. (See glossary on page 3.)

For warehouses, the CIBSE Code recommends illuminance values ranging from 100 lux to 300 lux, but the values given relate only to open work areas. They cannot be readily applied to racking stores, where it is generally more important to be able to see details in a vertical, rather than a horizontal plane, and luminaires are required that preferentially light these vertical surfaces.

The energy loadings required to achieve this illuminance may be as much as 50% more than those required to provide a similar illuminance on a horizontal plane. See box (right) on how to target electrical loads.

### Target electrical loads

The CIBSE Code also recommends target ranges of installed load (or power density, in W/m<sup>2</sup> of floor area) per 100 lux maintained illuminance. The target range loadings for high bay and other industrial buildings (the latter includes low bay but not warehouses) are shown in table 1, and table 2 shows target loadings for warehouses.

In a large high bay factory that is lit by standard high pressure sodium lamps, for example, the target range is given as 1.1 W/m<sup>2</sup> to 2.1 W/m<sup>2</sup> per 100 lux. If the required maintained illuminance is 500 lux, the power density should therefore be within the range 5.5 to 10.5 W/m<sup>2</sup>.

Ideally, a lighting system's installed load per 100 lux will be towards, or below, the lower end of the appropriate range. However, there may be special lighting requirements and architectural constraints that justify values above the recommended range. Other factors affecting a system's placing in (or beyond) the recommended range may include any or all of the following:

- cleanliness of the luminaires and their environment (affected by standard and frequency of maintenance employed)
- reflector and diffuser characteristics
- differing reflectance characteristics, colours and shapes of the spaces to be lit
- differences in efficacies (light output per watt input) amongst lamps with different colour renderings
- effect on luminaire efficiency of differing reflector and diffuser components
- standard of maintenance employed.

There should not be undue complacency if a system's installed load appears reasonable, when compared with the target ranges given in tables 1 and 2. There could still be potential for substantial savings. The section headed 'How to cut costs' offers suggestions on ways in which these savings might be made. The box (right) explains how to calculate the installed load, and gives worked examples.

Lamp type	Target working plane power density range (W/m <sup>2</sup> per 100 lux)		
	Narrow *	Average **	Large ***
<b>High bay industrial</b>			
Metal halide, clear or coated	2.6 – 4.5	2.1 – 3.6	2.0 – 3.4
High pressure mercury-coated	4.2 – 6.2	3.5 – 5.1	3.3 – 4.8
High pressure sodium (standard or high efficiency)	1.4 – 2.7	1.2 – 2.2	1.1 – 2.1
<b>Other industrial (including low bay)</b>			
Fluorescent triphosphor	2.5 – 4.9	1.9 – 3.5	1.6 – 2.9
Fluorescent halophosphate	3.2 – 6.3	2.4 – 4.5	2.1 – 3.7
Metal halide, clear or coated	2.9 – 6.8	2.3 – 4.4	2.1 – 3.9
High pressure mercury-coated	4.8 – 9.4	3.7 – 6.1	3.5 – 5.5
High pressure sodium (standard or high efficiency)	1.8 – 4.7	1.3 – 3.0	1.3 – 2.7

\* where shortest plan view dimension = approximately 2 x height  
 \*\* where shortest plan view dimension = approximately 4 x height  
 \*\*\* where shortest plan view dimension = approximately 10 x height

**Table 1 Target ranges of installed power density per 100 lux**

Type of storage	Light distribution	Typical electrical loading (W/m <sup>2</sup> )
Open floor, low height	Wide dispersive, any lamp	7 – 9
Open floor, tall stacks	Wide dispersive between stacks, any lamp	8 – 10
Wide aisle, low racks	Wide dispersive, transverse fluorescent	9 – 12
Wide aisle, tall racks	Special (floodlight), discharge lamp	15 – 20
Narrow aisle, low racks	Special (racking reflector), fluorescent	20 – 35
Narrow aisle, tall racks	Special (racking reflector/refractor), any lamp	25 – 50

The area used to calculate the loading is that of the clear aisle and not the gross area of the store hence the loadings are much higher than might be expected.

**Table 2 Typical electrical loadings for warehouses, for an average horizontal illuminance of 300 lux**



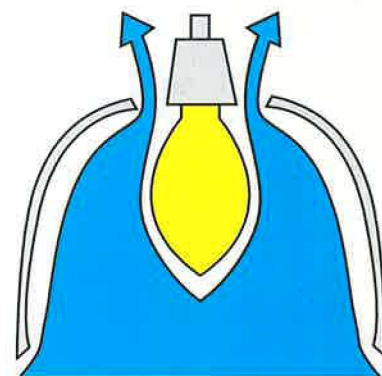
### Lighting systems

**General (or uniform) lighting** provides an approximately uniform illuminance on the horizontal working plane over the entire area being served. The luminaires are arranged in a regular layout, giving a tidy appearance to the installation. General lighting is simple to plan and install. It requires no co-ordination with task locations, which may not be known or which may change, but energy will be wasted if whole areas are illuminated to levels that are needed only for the most critical tasks.

**Localised lighting** saves energy by employing

an arrangement of luminaires related to the position of tasks and work stations. These provide the required illuminance on work areas, together with a lower level of general illumination for the space. By careful luminaire positioning, good light utilisation is achieved with few problems from shadows, reflections and discomfort glare.

**Local (or task ambient) lighting** can satisfy special lighting requirements for small areas or specific tasks. A local system supplements a general lighting system, which provides ambient illumination for circulation and non-critical tasks.



### How to calculate and compare the installed load

To find the installed load, count the number of lamps of each kind, multiply by their nominal ratings (in watts), apply correction factors where necessary, and divide the total by the floor area that is served (in square metres) to give a loading in W/m<sup>2</sup>.

Lamp ratings are normally printed on the lamp. For dual power fluorescent tubes, (eg 65 W/80 W) use the lower rating unless the fittings are more than about 15 years old.

Correction factors are applied to discharge and fluorescent lamps to allow for power losses in their control gear. For compact fluorescent lamps with their own control gear (ie the replacement type) and tungsten light bulbs, use the rated value printed on the lamp. For other lamps, refer to the manufacturers' data, or use the typical correction factors below.

Lamp type	Correction factor for control gear
Fluorescent with wire-wound control gear	1.25
High pressure discharge lamps (SON, MBF, etc)	1.10
(For fluorescent with HF control gear, refer to manufacturer's data)	

Comparing the calculated installed load with the values given in table 1 or 2 will give an indication of whether it is better, worse or on a par with the good practice industry average for this type of installation.

### Sample calculations

**1. Low bay assembly workshop**, 35 m x 12 m x 3.5 m high (this is an 'average' space, see the definition given in table 1). Five rows of 10 luminaires, each with twin 65 W fluorescent halophosphate lamps, give 500 lux maintained illuminance.

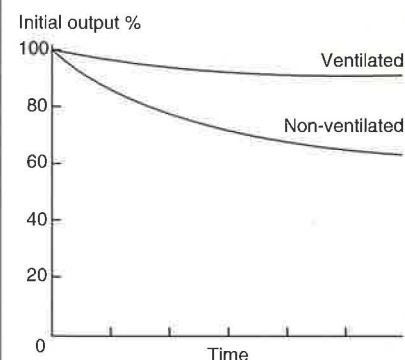
Total lamp power	$5 \times 10 \times 2 \times 65 = 6500 \text{ W}$
Correction for control gear	$6500 \times 1.25 = 8125 \text{ W}$
Area of workshop	$35 \times 12 = 420 \text{ m}^2$
Installed load	$8125 \text{ divided by } 420 = 19.3 \text{ W/m}^2$
Installed load per 100 lux	$3.9 \text{ W/m}^2$

Table 1 suggests 2.4 W/m<sup>2</sup> to 4.5 W/m<sup>2</sup> per 100 lux for an average-width, low bay workshop, such as this. The calculation shows the installed load is towards the upper end of this range. Replacing the 65 W halophosphate lamps with 58 W triphosphor lamps would reduce the installed load from 3.9 W/m<sup>2</sup> to about 3.0 W/m<sup>2</sup> per 100 lux.

**2. High bay assembly workshop**, 105 m x 28 m x 8 m high (this space is 'average' see the definition given in table 1). Five rows of 25 luminaires, each with a 250 W SON lamp, give 500 lux maintained illuminance.

Total lamp power	$5 \times 25 \times 250 = 31\,250 \text{ W}$
Correction for control gear	$31\,250 \times 1.1 = 34\,375 \text{ W}$
Area of workshop	$105 \times 28 = 2940 \text{ m}^2$
Installed load	$34\,375 \text{ divided by } 2940 = 11.7 \text{ W/m}^2$
Installed load per 100 lux	$2.3 \text{ W/m}^2$

Table 1 suggests 1.2 to 2.2 W/m<sup>2</sup> per 100 lux for an average bay.



*Using a perforated reflector induces an air flow that reduces accumulation of dirt on the lamp, and consequent degradation of light output*

### How to calculate annual consumption and costs

Having calculated the installed load, the next step is to estimate the number of hours in a year that the lights are switched on. If some parts of the system are switched independently, consumption and cost values will have to be worked out for each, and then added together.

The sums can be done by averaging the number of hours the lights are on each day, and multiplying this by the number of days in the year that the building is in use. Care is required here, because lighting use will be affected by daylight availability (assuming the building has windows) as well as by occupancy pattern, so it will vary with time of year.

The annual consumption is then expressed in kWh/m<sup>2</sup>, and when this is multiplied by the unit price (per kWh) of electricity, the annual electricity cost for lighting will be known.

### Could you do better?

Table 1 gives target values of good practice installed load, and EEO Energy Consumption Guide 18 gives an indication of good practice annual consumption values for industrial buildings. Special circumstances affecting lighting requirements apply in almost every case, and the values indicated in EEO Energy Consumption Guide 18 and this document can only serve as a guide. Any user whose system appears to be significantly less efficient would be well advised to find out why and consider possibilities for improvement.



### How to cut costs

The cost of lighting can be cut by reducing the hours of use, and by improving the efficiency of the system. Ways to achieve these goals include the provision of better switching and maintenance arrangements.

### Reducing hours of use

A factory working a 39 hour week will aggregate about 2000 hours of use per annum. If an additional evening or night shift is worked, this will increase by 50% or more. Electric light may be necessary for the whole of this period or, if daylight is available in the work space, it may be required only during the hours of darkness.

The greatest waste of energy in lighting results from lamps being used unnecessarily. Improved manual switching arrangements and good housekeeping campaigns (whereby staff are encouraged to be conservation-minded) can sometimes provide a satisfactory solution, but automatic controls are often a cost-effective investment.

When there is good daylighting potential, controls triggered by photoelectric sensors may be appropriate, and when occupancy patterns are known, timer controls can be used to switch lights on and off at predetermined times. In intermittently used spaces such as storage areas, and particularly where people cannot easily operate light switches (for example fork-lift truck drivers and people carrying or pushing equipment), the use of electronic presence-sensing controls can be cost-effective. For more information see the section headed 'Switching'; and BRE Digest 272: 'Lighting controls and daylight use'[5]. In addition, several EEO Case Studies describe situations where automatic lighting controls are being used to good effect.

In many factories, the largest use of energy is in space heating, and it may be cost-effective to block out any roof glazing with insulating materials. Every case must be judged on its merits to determine whether the savings on heating are greater than the increased cost for artificial lighting. Guidance for decision makers can be found in EEO Expanded Project Profile 202: External insulation on a factory roof[6].

Daylight from roof and side glazing can make a significant contribution to the working illuminance, with a consequent saving in electricity consumption, but to maximise this potential the windows must be kept clean. In general, rooflights provide a better distribution of daylight in a building than similar size windows. Natural light from side glazing quickly diminishes across the space and, depending on orientation, there can be problems with glare.

### Switching

In many cases the lighting will be switched either in blocks or in rows, running across the space at right angles to any side glazing. In these cases it will not be possible to switch off lighting near the windows without depriving workers further away. In order to maximise energy savings, switching should be arranged so that rows, or partial rows, parallel to side glazing can be individually controlled. A similar provision can be made in relation to rooflights.

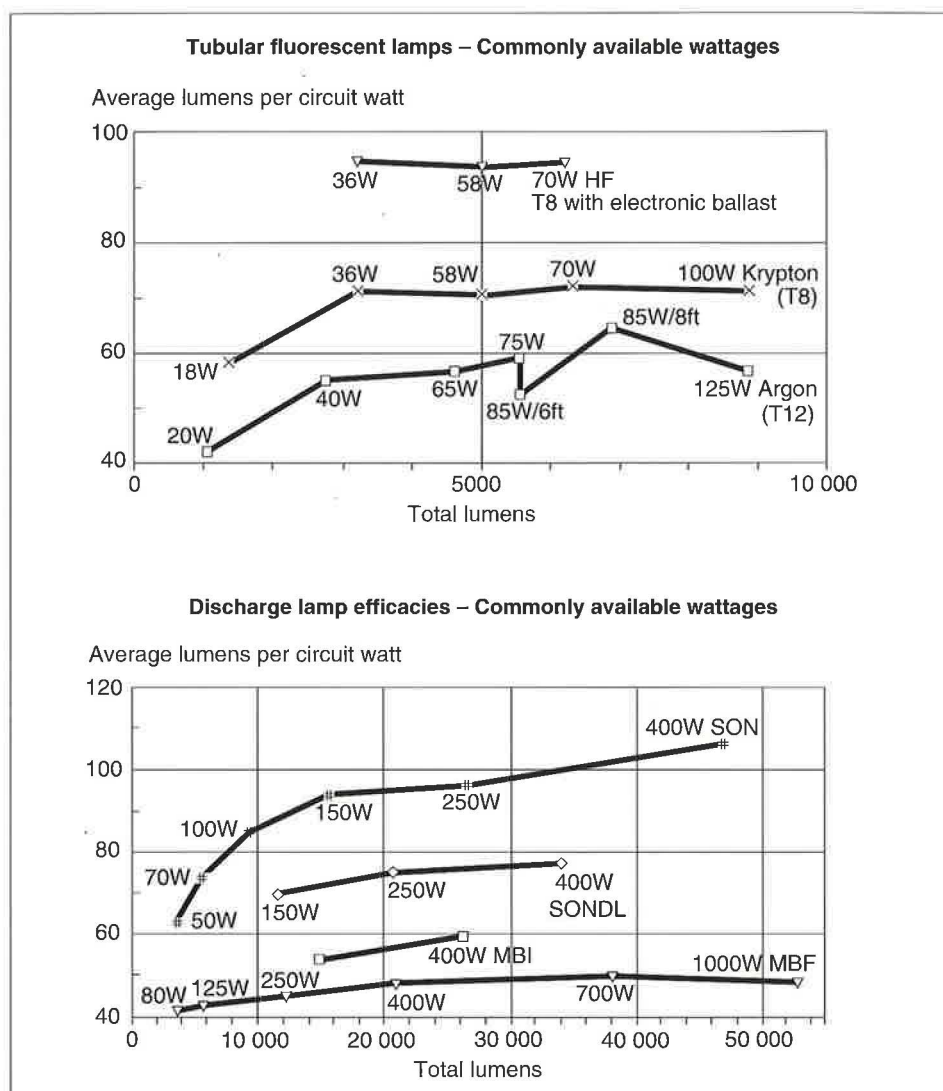


Figure 1 Relative efficacies (light output per watt input) of commonly available lamps

Experience and research has shown that, even where selective switching is possible, there is a tendency for lighting to be turned on at the beginning of the day and left on until the last person leaves at night, regardless of whether or not it is serving a useful function. In order to maximise savings, lighting controls should be designed to take account of occupancy patterns and daylight availability (see BRE Digest 272[5]). Some of the possibilities are as follows.

- **Manual switching.** Ensure lights are wired so that they can be turned off in small numbers parallel to the glazing. Appoint an individual to ensure that lighting is turned off at the end of the day and at lunchtime. Luminaires controlled by a single switch should be restricted to a single logical working area so that, when this area is not in use, the lighting can be turned off without affecting other areas.
- **Time switches** can turn lighting on and off at preset times on chosen days. They can also switch off lights (after a preset interval) that have been switched-on manually. Two time switches can operate a staggered pattern, the first switching access lighting and the second the main production areas. For safety, leave a small number of fittings on manual control to

avoid plunging the space into darkness while it is still occupied. Remember to allow for weekends and holidays.

- **Photoelectric cells** can measure the daylight contribution at a point in the space and switch the lighting on or off as necessary. A time delay is usually built-in to cater for short-term variations in daylight, caused for example by passing clouds.
- **Presence detectors** use acoustic, passive infra-red or ultrasonic means to detect whether people are in the scanned area. They can turn lighting on when they detect a presence, and off after a preset time with no presence detected.
- **Combinations of the above.** Use time switches to control main corridors and access areas; photocells where roof or side glazing provides daylight; and presence detectors for infrequently or intermittently used areas.

Automatic switching and dimming systems work best with fluorescent lamps. Remember that high pressure discharge lamps cannot give light instantly and will need time to warm up. Always leave some lighting on manual control to cater for system failures and for safety.



**Good Practice Case Study 158**

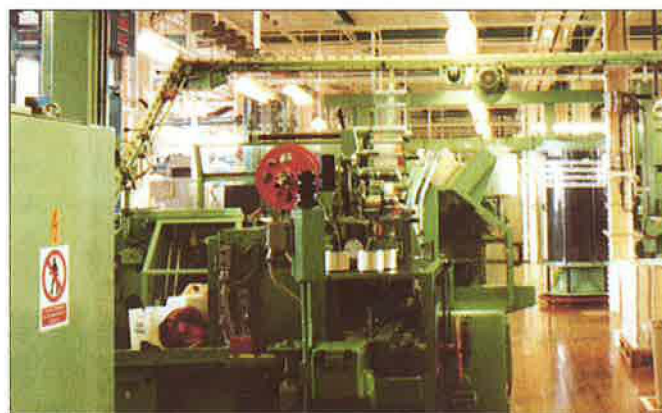
*Cosmetics packing hall: the lighting requirements for a new, low bay packing hall could have been satisfied with a basic, no-frills fluorescent system. However, by investing a little more time on design and money on components, a system was achieved with the same type, size and number of fluorescent lamps that produces a better quality of lighting, and cuts electricity bills by over 70%.*

**Good Practice Case Study 159**

*Brewery: major changes to plant and structure in a long-established brewing and fermentation building caused the lighting system to be highly inefficient. Modernisation and rationalisation of the system led to savings of 66% in electricity consumption and costs, and 40% in maintenance costs. Overall payback on investment was under 2.5 years.*

**Good Practice Case Study 169**

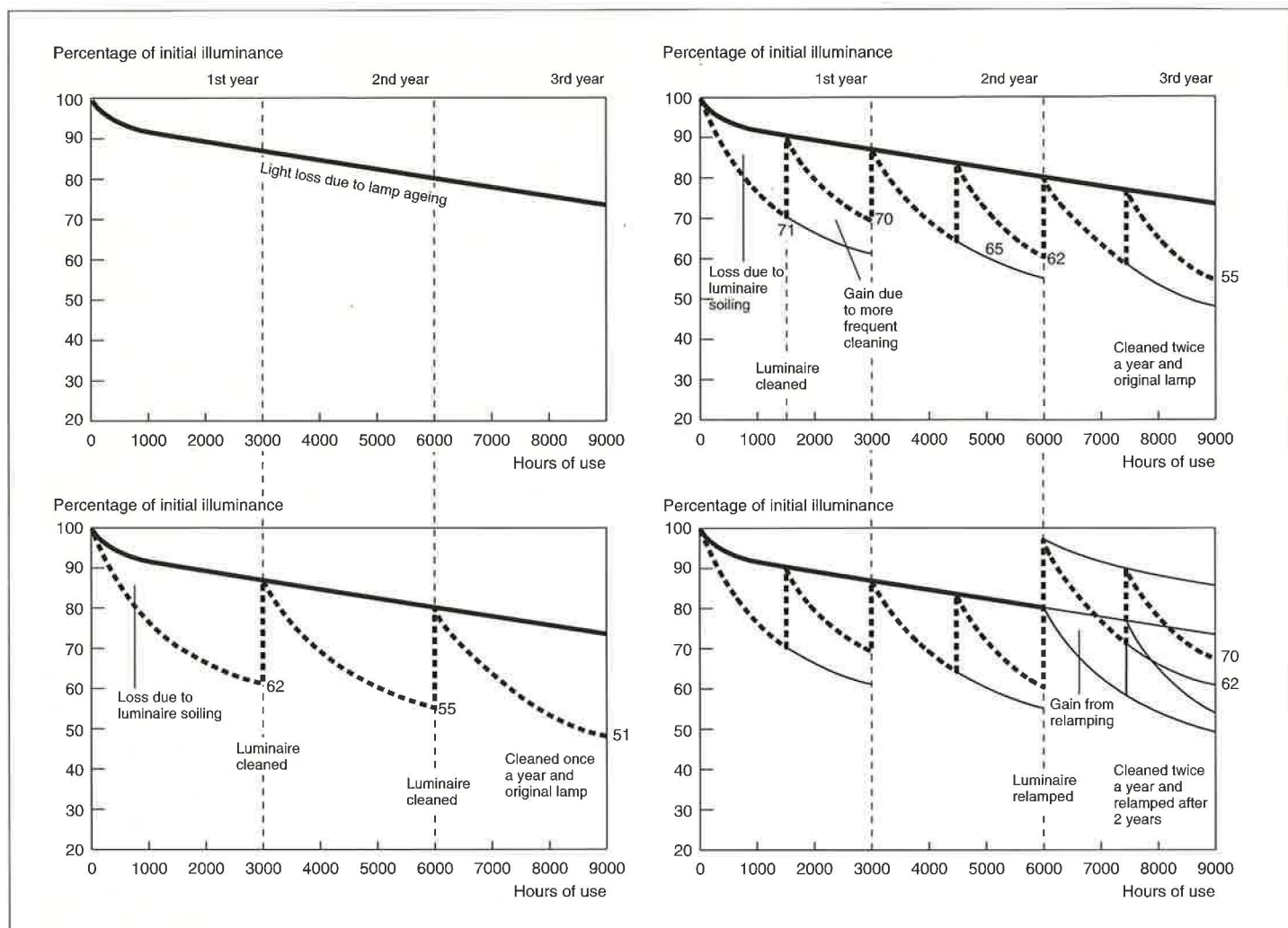
*Cigarette factory: modernisation and rationalisation of the fluorescent lighting in a 90-year old, four-storey factory gave 64% savings in electricity costs, with payback expected within 30 months. Savings were achieved mainly by fitting higher efficiency fluorescent luminaires with 26 mm diameter tubes and electronic control gear, and by reducing the time that lamps are lit.*

**Good Practice Case Study 174**

*Meat processing plant: lighting costs were cut in this bacon processing hall by simply replacing the fluorescent lamps and control gear, while retaining the original enclosures, diffusers and reflectors. This gave electrical energy and costs savings of 57%, and led to 25% savings on maintenance costs, with payback expected within 18 months.*







**Figure 2 Typical effect on illuminance of ageing and different maintenance regimes (Reproduced from CIBSE Code for Interior Lighting (1994) by permission of CIBSE)**

### Improving efficiency

In recent years, the efficacies of fluorescent lamps and fittings in particular have been greatly improved (see figure 1). As a result, compact fluorescent lamps are replacing tungsten lamps, and 26 mm diameter fluorescent tubes are replacing the old-style 38 mm diameter tubes as standard in new installations.

All discharge lamps (including fluorescent) require control gear with a ballast to initiate the arc when first switched on, to stabilise the current after ignition, and (usually) to correct the power factor (see glossary). Energy is consumed by the ballast, and the efficiency of a lamp circuit as a whole depends on the total power taken by the lamp and the ballast.

Conventional ballasts have wire-wound chokes that operate lamps at mains frequency, and generally consume far more power than the alternative HF (high frequency) electronic types that are now available.

When used with conventional switch-start control gear, a 26 mm diameter fluorescent tube consumes about 8% less power to provide the same light output as a 38 mm diameter tube. A fluorescent lamp's efficacy improves with increasing frequency, and a luminaire fitted with the new slimmer tubes and an HF ballast will

consume about 20% less power for a given light output than an old-style fitting with switch-start control gear and 38 mm tubes. These savings result partly from improved performance of the lamp, and partly from reduced energy losses in the electronic ballast itself.

Operating fluorescent lamps at high frequency has a number of other benefits, including quicker starting, an absence of flicker and stroboscopic effects, and a reduced incidence of reported headaches and eye strain.

Compact fluorescent lamps are energy efficient alternatives to tungsten light bulbs. They use about 40% of the power of a tungsten bulb of similar light output, and last up to eight times as long.

The efficiencies of other types of lamps have also improved. In particular, there have been major advances in high pressure sodium (SON) lamps, which offer attractive energy saving and long life advantages. Some, for example, have excellent colour rendering characteristics, while others have been developed as direct replacements for 250 W and 400 W high pressure mercury lamps (avoiding the expense of changing the light fitting or control gear).

Figure 1 shows relative efficacies of major lamp types and table 3 indicates savings potential

and payback periods for a range of energy efficiency measures.

### Maintenance

No matter how efficient a lighting system may be, when first installed, it will not remain so without systematic, regular maintenance.

The output from all lamps declines with use, and is further reduced by accumulations of dirt on the luminaires. While continuing to consume the same power as when new, a lamp's output may decline by 50% or more before it fails. All luminaires should be cleaned at regular intervals, therefore, and most lamps should be changed at the end of their useful life, which is usually before they fail. The relatively high unit cost of high pressure discharge lamps, however, means that in this case replacement before failure is not always cost-effective.

Figure 2 shows a typical reduction of illuminance owing to lamp or luminaire soiling and ageing, and the beneficial effect of frequent cleaning. This decline in performance is usually allowed for in the initial design, so that when new the illuminance is above that required. With the assurance of regular cleaning and lamp replacement this initial over-lighting can be greatly reduced, with substantial energy and capital cost savings.



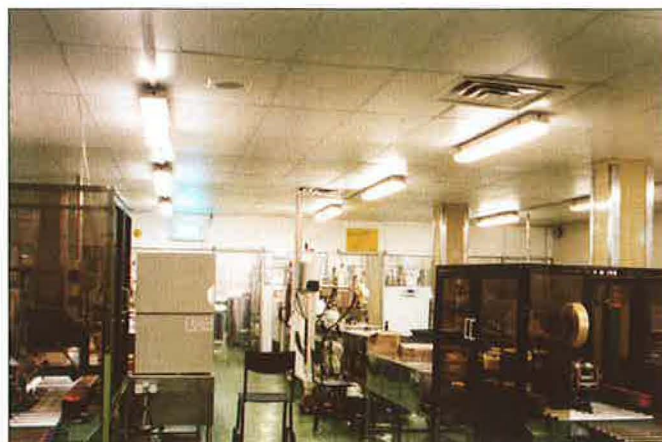


**Light stores:** modernising the fluorescent lighting system and fitting special reflectors gave 39% savings in electrical consumption and costs, with a 5-year payback. The new reflectors have greatly improved vertical illuminance on the sides of the racks.



**Heavy stores:** in a high bay area where large spare parts are stored on the floor and daylighting is good, the use of timed push-button controls has cut lighting costs by 80%. In another part of the same building, where heavy parts on pallets are stored in racks, the use of presence sensors has cut lighting costs by 90%.

**Dairy:** modernising the obsolete fluorescent lighting in this cheese-packing hall would have cut electricity costs by 30%, with a 3.5-year payback. A far better and quicker return on investment was achieved, however, by removing one lamp from each of the twin-lamp luminaires, and fitting reflectors to direct the light more precisely to where it is required.



**New, low bay factory:** Some of the best lighting schemes are remarkably simple. This small installation in a new factory unit, comprising metal halide lamps controlled in zones by manual switching, won a top lighting award because it was judged to provide an outstanding example of a design that satisfies all user requirements. Using high efficiency modern components, and exploiting natural and reflected light potential, is said to have cut electrical lighting costs by nearly half.





Current situation	Action	Saving	Payback	Applicable to:		
				Low bay	High bay	Warehouse
Lighting over 10 to 15 years old	Consider complete replacement	30 to 70%	Medium – Long	✓	✓	✓
Fluorescent luminaires using 'quick-start' or 'instant start' control gear	Replace with 'switch-start' or (preferably) HF ballasts	8 to 30%	Medium – Long	✓	✓	✓
System using 38 mm diameter fluorescent tubes	Check whether 26 mm diameter tubes can be used as replacements	About 8%	Short	✓	✓	✓
System using white enamelled reflectors	If enamelled reflectors not essential, replace with glass or specular materials	8 to 30%	Medium if number reduced		✓	
System using white reflectors, opal diffusers or 'eggcrate' louvre	Replace with prismatic material	20 to 50%	Medium if number reduced*	✓		
	Replace with specular 'racking' reflectors	20 to 50%	Medium if numbers reduced			✓
High pressure mercury discharge lamps	Consider plug-in SON replacements, or replace complete lamp/gear with SON (DL)	Plug-in 15% All new 50%	Short Medium		✓	✓
Tungsten lamps	Replace with compact or tubular fluorescent fittings, preferably with HF ballasts	50 to 70%	Medium	✓		✓
Manual lighting controls	Install automatic lighting controls	20 to 50%	Medium	✓	✓	✓

Payback will depend on the efficiency of the original installation, but typically:  
short = less than 2 years; medium = 2 to 5 years; and long = more than 5 years

**Table 3 Possible actions with typical benefits and payback periods**

### What to do next

If there appears to be good potential for cost-effective energy saving measures on lighting the following actions should be taken.

- Ensure that good housekeeping tasks are properly carried out, with lamps and luminaires cleaned and replaced at regular intervals.
- Question whether power factor can be improved to minimise consumption and charges on kilovar (kVar) metered supplies, and whether tariff agreements can be modified to further reduce electrical costs.
- Seek professional advice on what other measures can be taken to reduce energy consumption.

### References

- [1] Energy Consumption Guide 18 Energy efficiency in industrial buildings and sites.
- [2] Lighting for work, published by the Health & Safety Executive.
- [3] CIBSE Code for Interior Lighting 1994.
- [4] CIBSE Lighting Guide LG1: The industrial environment.
- [5] BRE Digest 272: Lighting controls and daylight use.
- [6] EEO Expanded Project Profile 202 External insulation on a factory roof.
- [7] Environmental aspects of lighting by E T Glenny, 'Energy Management' magazine, pages 18-19, September/October 1993).

### Environmental aspects of lighting

A life cycle analysis of the eight principal lamp types shows that the main negative environmental effect is the consumption of electrical energy when the lamp is switched on. This conclusion is based on studies of environmental pollution throughout each lamp type's life span, from extraction of raw material to waste disposal.

Lamps which cause least environmental disturbances are, therefore, those which are the most energy efficient and produce most light per unit energy, ie highest lamp efficacy<sup>[7]</sup>.



**Presence detectors such as this use acoustic, passive infra-red or ultrasonic means to detect whether people are in the scanned area**

### Further information

Further information on standards to aim for, savings possibilities and how to achieve them can be found in the following documents.

- LIF (Lighting Industry Federation) Energy Managers Lighting Handbook.

### EEO publications, available from BRECSU

- ECON 19 Energy efficiency in offices
- GPG 61 Design Manual: Energy efficiency in advance factory units
- GPG 62 Occupiers Manual: Energy efficiency in advance factory units
- Series of Case Studies giving specific examples of good practice lighting installations in various types of factories and warehouses.

### THERMIE

- Thermie Maxibrochure: Energy efficient lighting in industrial buildings.



